AFRL-RH-WP-TP-2013-0045

Fully Articulating Air Bladder System (FAABS): Noise Attenuation Performance in the HGU-56/P and HGU-55/P Flight Helmets

Hilary L. Gallagher
Warfighter Interface Division
Battlespace Acoustics Branch

October 2013

Interim Report

AIR FORCE RESEARCH LABORATORY
711 HUMAN PERFORMANCE WING,
HUMAN EFFECTIVENESS DIRECTORATE,
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE

NOTICE AND SIGNATURE PAGE

Using Government drawings, specifications, or other data included in this document for any purpose other than Government procurement does not in any way obligate the U.S. Government. The fact that the Government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey any rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report was cleared for public release by the 88th Air Base Wing Public Affairs Office and is available to the general public, including foreign nationals. Copies may be obtained from the Defense Technical Information Center (DTIC) (http://www.dtic.mil).

AFRL-RH-WP-TP-2013-0045 HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION IN ACCORDANCE WITH ASSIGNED DISTRIBUTION STATEMENT.

//signed//
Richard L. McKinley
Work Unit Manager
Battlespace Acoustics Branch

//signed//
Robert C. McKinley
Chief, Battlespace Acoustics Branch
Warfighter Interface Division

//signed//
William E. Russell, Acting Chief
Warfighter Interface Division
Human Effectiveness Directorate
711 Human Performance Wing

This report is published in the interest of scientific and technical information exchange, and its publication does not constitute the Government's approval or disapproval of its ideas or findings.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
10-10-2013	Interim	June 2013 – September 2013

4. TITLE AND SUBTITLE
Fully Articulating Air Bladder System (FAABS): Noise Attenuation Performance in the HGU-56/P and HGU-55/P Flight Helmets

5a. CONTRACT NUMBER
FA8650-08-D-6801-0027

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
62202F

6. AUTHOR(S)
Hilary L. Gallagher

5d. PROJECT NUMBER
7184

5e. TASK NUMBER
718416

5f. WORK UNIT NUMBER
71841620/H03P

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
711 Human Performance Wing
Human Effectiveness Directorate
Warfighter Interface Division
Battlespace Acoustics Branch
Wright-Patterson AFB OH 45433

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Materiel Command
Air Force Research Laboratory
711 Human Performance Wing
Human Effectiveness Directorate
Warfighter Interface Division
Battlespace Acoustics Branch
Wright-Patterson AFB OH 45433

10. SPONSOR/MONITOR'S ACRONYM(S)
711 HPW/RHCB

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
AFRL-RH-WP-TP-2013-0045

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A: Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

88 ABW/PA Cleared 02/03/2013; 88ABW-2014-0327.

14. ABSTRACT

The Air Force Research Laboratory's (AFRL) Battlespace Acoustics Branch collected passive noise attenuation performance data on both the HGU-56/P and the HGU-55/P flight helmets with the Fully Articulating Air Bladder System (FAABS) to compare to the noise attenuation performance of the helmets with regular shims. All data was collected in accordance with ANSI S12.6-2008. The noise attenuation performance results revealed that the helmets with FAABS performed better when compared to the helmets with regular shims across all frequencies from 125 to 8000 Hz (except at 2000 Hz where equal performance was measured in the HGU-56/P helmet). Any modification to the helmet system must first receive approval before flight; these measurements meet the safe-to-fly checklist requirement for noise attenuation.

15. SUBJECT TERMS HGU-56/P, HGU-55/P, flight helmet, hearing protection, REAT, noise attenuation

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Richard McKinley
U	U	U	SAR	12	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

THIS PAGE IS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Flight helmets are required in-flight for many reasons: impact/ballistic protection, communications, and hearing protection. The HGU-56/P flight helmet was designed for rotor wing pilots and the HGU-55/P flight helmet was designed for fixed wing pilots. Both flight helmets have communication earcups that are secured in the helmet with foam shims and velcro attachments. The shims are also used to create a seal between the earcups and the pilot's head. Warrior Edge developed a system that could replace the shims called the Fully-Articulating Air Bladder System (FAABS). FAABS was designed to give the pilot the ability to manually inflate/deflate the air bladders with a finger pump.

The Air Force Research Laboratory's (AFRL) Battlespace Acoustics Branch collected passive noise attenuation performance data on both the HGU-56/P and the HGU-55/P helmets with the FAABS to compare to the noise attenuation performance of the helmets with regular shims. All data were collected in accordance with ANSI S12.6-2008.[1] The noise attenuation performance results revealed that the helmets with FAABS performed better when compared to the helmets with regular shims across all frequencies from 125 to 8000 Hz (except at 2000 Hz in the HGU-56/P helmet where attenuation performance was equivalent). Any modification to the helmet system must first receive approval before flight; these measurements meet the safe-to-fly checklist requirement for noise attenuation.

1.0 INTRODUCTION

HGU-56/P and HGU-55/P flight helmets (Figure 1) provide protection to aircrew in rotor- and fixed-wing aircraft. Foam shims (Figure 2) are used to stabilize the helmet by providing pressure behind the earcups. FAABS (Figure 3) was designed to improve helmet stability as well as to create an earcup seal via an equalizing bladder. FAABS was also crafted to increase the pilot's comfort levels while wearing the flight helmet by eliminating hot spots and ultimately reducing mission fatigue.

Figure 1. HGU-56/P (left) and HGU-55/P (right) flight helmets

Figure 2. Regular foam shim inside a HGU-55/P flight helmet

Figure 3. Fully-Articulating Air Bladder System (FAABS)

2.0 METHODS

2.1 Subjects

Ten paid volunteer subjects (5 male, 5 female) participated in the noise attenuation performance measurements. All subjects had hearing threshold levels less than or equal to 20 dB hearing level (HL) from 125 to 8000 Hz. The subjects ranged in age from 21 to 30 with a mean age of 25 years.

2.2 REAT – Passive Noise Attenuation

The AFRL Real Ear Attenuation at Threshold (REAT) facility was used to measure the passive attenuation performance of flight helmets with and without FAABS. The facility was built for the measurement, analysis, and documentation of the sound attenuation properties of passive hearing protection devices. The chamber, its instrumentation, and measurement procedures were in accordance with ANSI S12.6-2008.[1] The procedures described in ANSI S12.6 consist of measuring the open ear (without the hearing protector) and occluded ear (with the hearing protector, Figure 4) hearing thresholds of human subjects using a von Békésy tracking task. Psychoacoustic thresholds were measured two times for the open ear condition and two times for the occluded ear condition. The real-ear attenuation at threshold for each subject was computed at each octave frequency, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz, by averaging the two trials (the difference between open and occluded ear hearing thresholds). The mean and standard deviation at each frequency was then calculated across subjects.

Figure 4. Subjects in REAT facility with and without the HGU-56/P flight helmet

3.0 RESULTS

Passive noise attenuation performance measurements were collected on the HGU-56/P and HGU-55/P flight helmets worn in conjunction with FAABS. Additionally, noise attenuation measurements were collected on the HGU-56/P helmet with regular shims to directly compare the effect of FAABS and shims. Previous data had been collected in 2001 on the HGU-55/P helmet with regular shims.

Mean and standard deviation passive noise attenuation data of the HGU-56/P flight helmet in conjunction with FAABS and regular shims were calculated and are listed in Table 1. Mean noise attenuation data are plotted for both conditions in Figure 5. Results indicate that the HGU-56/P with the FAABS provided higher mean passive noise attenuation across all frequencies when compared to the helmet with regular shims except at 2000 Hz, where equal attenuation was measured.

Table 1. Mean and standard deviation passive noise attenuation data for the HGU-56/P flight helmet

Helmet Configuration		Frequency (Hz)						
		125	250	500	1000	2000	4000	8000
HGU-56/P with FAABS	Mean	10	11	17	32	34	44	46
	SD	8	7	4	6	4	6	5
HGU-56/P with Shims	Mean	7	8	13	27	34	37	39
	SD	6	6	5	4	6	7	8

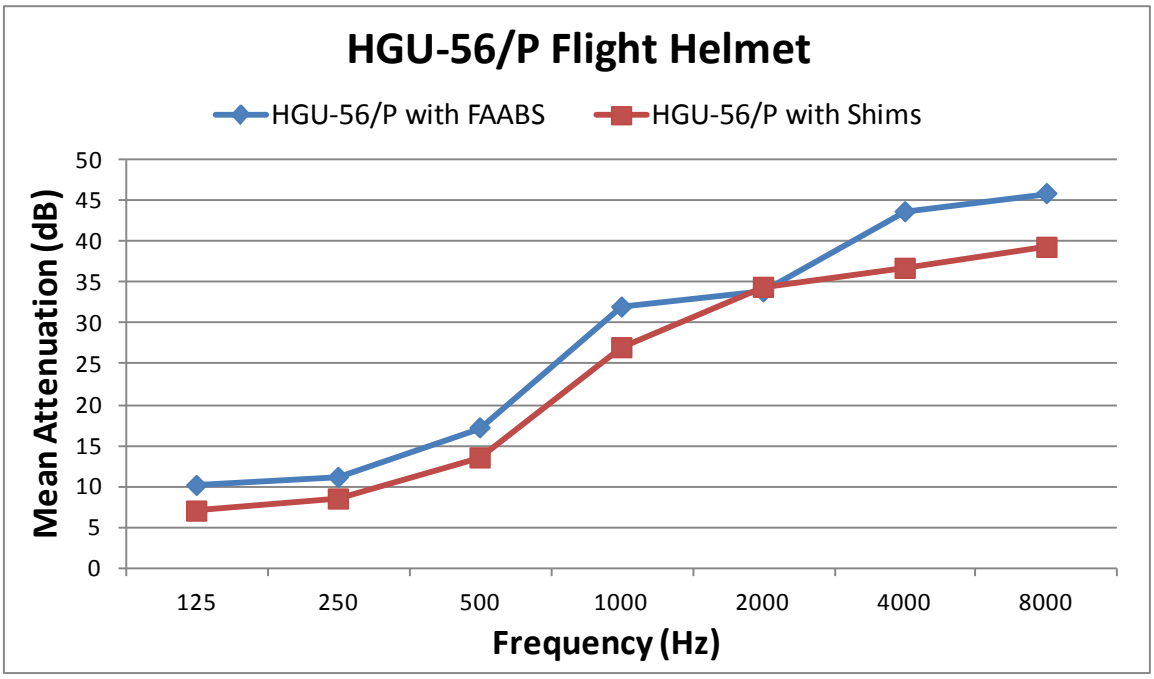

Figure 5. Mean passive noise attenuation performance of the HGU-56/P with and without FAABS

Mean and standard deviation passive noise attenuation data of the HGU-55/P flight helmet in conjunction with FAABS and regular shims were calculated and are listed in Table 3. Mean noise attenuation data are plotted for both conditions in Figure 6. Results indicate that the HGU-55/P flight helmet with FAABS provided higher mean passive noise attenuation results across all frequencies when compared to the HGU-55/P with regular shims.

Table 2. Mean and standard deviation passive noise attenuation data for the HGU-55/P flight helmet

Helmet Configuration		Frequency (Hz)						
		125	250	500	1000	2000	4000	8000
HGU-55/P with FAABS	Mean	14	12	21	32	38	51	58
	SD	6	4	5	5	6	7	7
HGU-55/P with Shims (2001)	Mean	9	8	15	28	37	50	54
	SD	6	4	4	3	4	4	4

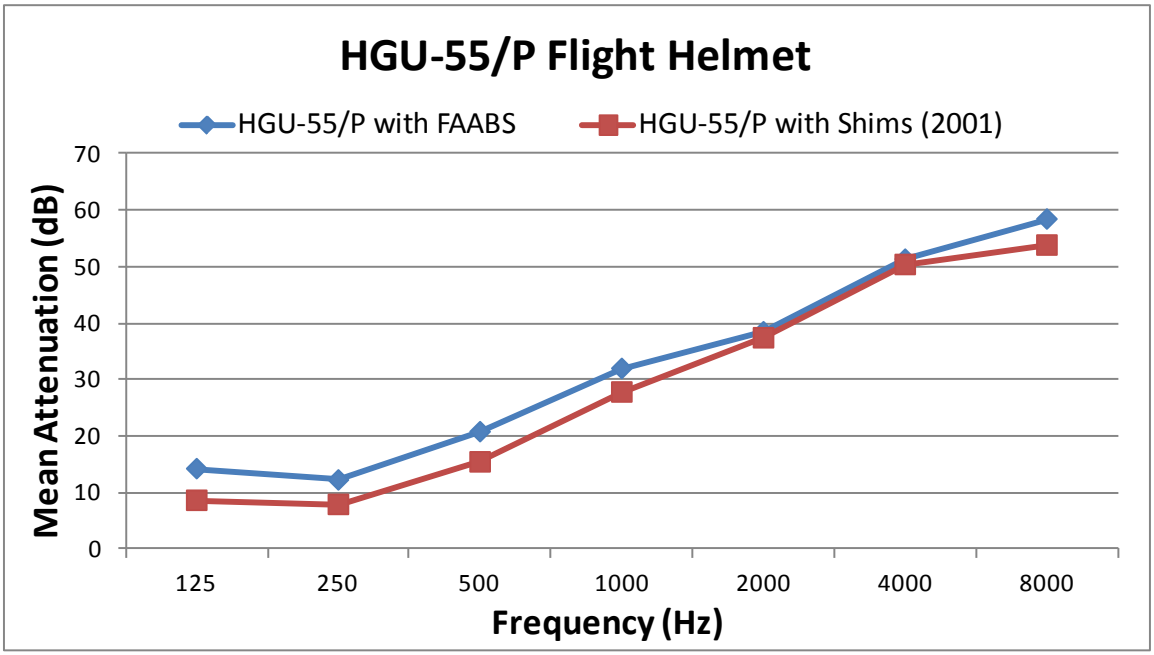

Figure 6. Mean passive noise attenuation performance of the HGU-55/P with and without FAABS

4.0 CONCLUSION

Passive noise attenuation performance was measured for the HGU-56/P and HGU-55/P flight helmets to compare the effect the FAABS and regular foam shims had on the protection level of the helmet. The HGU-56/P with the FAABS provided higher mean passive noise attenuation across all frequencies when compared to the helmet with regular shims except at 2000 Hz, where equal performance was measured. The HGU-55/P flight helmet with FAABS provided higher mean passive noise attenuation results across all frequencies when compared to the HGU-55/P with regular shims.

All measurements were collected in accordance with ANSI S12.6-2008.[1] The REAT data presented in this report are suitable for use in noise exposure calculations for the DoD and individual service hearing conservation programs.

5.0 REFERENCE

1. ANSI S12.6-2008 American National Standard Methods for Measuring the Real-Ear Attenuation of Hearing Protectors